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RADIO USES OF PIEZO-ELECTRIC CRYSTALS

Piezo-electricity is a phenomenon which has been known for many years but which is having some remarkable new applications. Certain crystals undergo a slight expansion or contraction when an electrical voltage is applied to them and, vice versa, produce a slight voltage when compressed or pulled. A piece of quartz crystal 1 or 2 inches long has a high natural frequency of the same order as the frequencies of currents used in radio communication. It has been found that the frequency of vibration of the piece of quartz is extraordinarily constant and that it is very useful as a radio standard. In association with a small electron tube it acts as an oscillator or generator of a current the frequency of which is that of mechanical vibration of the piece of crystal. As the frequency thus produced is accompanied by numerous harmonics, the crystal is a standard giving several radio-frequencies. It is thus a remarkable supplement to the wave meters which have hitherto been used as standards of radio-frequency.

A study just completed by the bureau indicates that such a quartz oscillator has many valuable applications in radio work. Means of producing audio as well as radio-frequencies were worked out. The crystals can be used to control or determine the frequency of a transmitting station and to hold it strictly constant, which will mean a great advance in radio-transmission technique. The crystals are also useful in accurate setting of receiving apparatus and in controlling the frequency of radio-

frequency generators used in laboratory measurement work. The value of these various applications is particularly great at the frequencies above 2,000 kilocycles which are now rapidly coming into use. A preliminary paper on this work has been prepared and will appear in the Proceedings of the Institute of Radio Engineers.

Part of the work resulted in the design of an outfit for use by the Department of Commerce radio inspectors and adapted to the rapid and accurate standardization of frequency meters. It consists of two instruments, both being simple devices of low power operated by dry batteries. Persons desiring to construct or procure these instruments can secure copies of specifications therefor from the Bureau of Standards. These specifications are Specifications for Portable Piezo Oscillator, Type N, and Specifications for Portable Auxiliary Generator, Type O. The bureau has also prepared a set of directions for the use of the two instruments, Letter Circular 183, Directions for Use of the Piezo Oscillator and Auxiliary Generator for Calibration of a Radio-Frequency Meter. It may be obtained upon application addressed to the Bureau of Standards, Washington, D. C., by persons having actual use for it.

ANTIKNOCK FUELS AND THE AUTOMOBILE OF THE FUTURE

So-called antiknock fuels are used extensively at the present time because they permit satisfactory operation of an engine which, because of an accumulation of carbon or too high a compression ratio, does not perform satisfac-

torily with the current grade of gasoline. Rather startling claims have sometimes been made relative to improvements in fuel economy to be expected when such fuels become so universally available as to permit engines to be designed to take full advantage of their possibilities.

Recognizing the widespread interest in this subject, the bureau has studied the factors determining the gains in fuel economy obtainable by the use of engines specially designed for the use of antiknock fuels.

It is well known that the use of an antiknock fuel permits the compression ratio of the engine to be increased, thus increasing the thermal efficiency and consequently the distance the car can travel per gallon of fuel. A fact less commonly recognized, however, is that since an increase in compression ratio increases the power of an engine, the size of engine necessary to provide a given car performance decreases as the compression ratio is increased. This results in an increase in mechanical efficiency which still further increases the mileage obtainable per gallon of gasoline. This effect is most pronounced under conditions of low mechanical efficiency such as occur when the engine is operating under rather low loads. As the motor-car engine operates much of its time under just such conditions, the gain realized in this way is of great importance. On the basis of certain well-justified assumptions it was calculated that the use of an antiknock fuel which would permit the compression ratio of the ordinary motor-car engine to be raised from 4.5 to 6.5 would yield an over-all increase in mileage per gallon of gasoline of more than 25 per cent.

It should be noted that if antiknock fuels become generally available and compression ratios are correspondingly increased, the situation will be much as it is at present in that an accumulation of carbon will make engine performance unsatisfactory. Consequently, there will still be a demand for an antiknock fuel superior to the then generally available product. One may expect, therefore, that the next few years will witness a

continuous trend toward the adoption of higher compression ratios and persistent and vigorous efforts toward the development of superior antiknock fuels.

REDUCTION IN NUMBER OF SIZES OF GRINDING WHEELS

A general conference of manufacturers, distributors, and users of grinding wheels was held under the auspices of the division of simplified practice on September 23. A reduction from 715,200 stock sizes to 255,800 was recommended and adopted by the conference. A report of the conference is now being circulated among members of the industry for acceptance. If accepted, this will be issued as a Recommendation in the Elimination of Waste Series.

STANDARDIZATION OF DIE HEADS AND CHASERS

On October 8 a meeting was held in the rooms of the American Society of Mechanical Engineers, New York, with a view to standardizing die heads and chasers used in the production of screws and bolts, the special object being the elimination of many of the special pitches and thread forms that have formerly been carried in stock. The meeting was attended by a very representative group of manufacturers of die heads and chasers and by members of the National Screw Thread Commission.

At this meeting it was agreed that the National Coarse, National Fine, National Straight Pipe Thread, and National Taper Pipe Thread Series, as adopted by the National Screw Thread Commission, the American Engineering Standards Committee, the American Society of Mechanical Engineers, and the Society of Automotive Engineers, shall serve as the basis for setting up a list of stockable sizes of chasers, and that all threads not coming within these National Standard Thread Series will be regarded as special and will not be carried regularly in stock.

A subcommittee was appointed to give further study to the needs of the screw-thread industry with a view to still further reducing the list of stockable sizes. This action on the part of manu-

facturers of die heads and chasers will have a very great influence in making effective the standardization work previously done by the National Screw Thread Commission and the national engineering societies, especially if similar action is taken by manufacturers of taps. By thus simplifying and standardizing threading tools the threaded product will itself become automatically standardized.

MANAGEMENT WEEK

At the request of the secretary of the joint committee in charge of national arrangements for Management Week, the division of simplified practice co-operated in furnishing names of possible speakers, as well as material to be used in working up programs. The purpose of Management Week was the holding of simultaneous educational meetings throughout the country to direct public attention to various specific problems of management. During the week of October 19 to 24, "Wastes in distribution" were discussed. Secretary Hoover, as honorary chairman of the joint national committee, addressed the National Distribution Conference. Speakers from the division made addresses during the week at Pittsburgh, Philadelphia, New York, and Boston.

CONCRETE BUILDING UNITS

With the increasing use of concrete block, brick, and tile in building construction numerous inquiries are being received at the bureau from prospective makers or users who wish to obtain detailed information relative to the properties of these units and manufacturing methods employed in their production. In order to care for these inquiries in a reasonably complete manner, a circular, entitled "The Properties and Manufacture of Concrete Building Units," has been prepared.

The general plan in the preparation of this paper has been not to give definite recommendations assumed to apply under all conditions of concrete-products manufacture, but to discuss along general lines the various factors govern-

ing the quality of the units. The maker is urged to study the available materials and to endeavor to improve his methods of manufacture so that the highest uniform quality of unit will be produced under the limitations set by local conditions.

The more important properties of concrete units are discussed, and some of the advantages of their use in masonry-building construction are set forth. Concrete block, tile, and brick have been defined, and the recommendations of the division of simplified practice for the standardization of sizes for the several types of units to avoid waste are given. The recommended standard sizes adopted are given, as well as the large number of sizes in present use. This comparison shows that by maintaining definite standards of size for the units a large saving will result in the outlay for machinery, molds, and pallets, as well as the stock to be carried in yards.

Various materials widely used in the manufacture of concrete products are described in detail. The questions of proper size and quality of both coarse and fine aggregates are discussed, and the use of admixtures, facing materials, and coloring processes are outlined. The need of careful proportioning, the proper time of mixing, the methods of molding, and the several means of curing are discussed at some length. The requirements for concrete units are dealt with from the structural, architectural, and fire-resistance viewpoints. The methods for conducting tests of concrete products and the proper interpretation of data from test reports are outlined. Factors affecting the financing of a concrete products plant are considered from an economic standpoint, and suggestions are made to prospective investors to investigate fully all local conditions which may affect the life and successful operation of a plant.

The circular proper is followed by a bibliography of books, technical papers, and periodicals dealing with various phases of the manufacture of these units which will be of particular interest to those contemplating entering this line

of work. There are also given several specifications from the standards of the American Society for Testing Materials governing the quality of aggregates and the method of testing, together with the American Concrete Institute's specifications for concrete block, tile, and brick.

TECHNOLOGY OF THE MANUFACTURE OF GYPSUM PRODUCTS

In 1904 the value of crude and calcined gypsum produced in the United States was \$2,750,000, with a tonnage of less than 1,000,000. According to the figures compiled by the United States Geological Survey, in 1924 the value had increased to approximately \$40,000,000 and the tonnage to more than 5,000,000. Therefore, it is not surprising that the bureau has received more and more inquiries relative to various phases of the technology of gypsum manufacture. These requests have become sufficiently numerous to warrant a publication covering the subject. To obtain the necessary data for such a paper 23 representative gypsum mills located at several of the larger gypsum deposits were selected and visited, and a general description of each is included in an appendix to the paper.

The object of the field work was to obtain complete information about the process of manufacture of calcined gypsum and gypsum products; to study the methods of mining, or quarrying, and crushing; to select typical samples of the raw material for analysis; to observe the methods of calcination, temperatures, and duration of calcination; to study the methods of sampling the calcined product; to follow this through the process of grinding, screening, and packing; and, finally, to observe the methods of manufacture of products made from calcined gypsum. The equipment employed and the processes used are correlated and compared.

The results of this investigation will be found in a forthcoming circular of the bureau, entitled "The Technology of the Manufacture of Gypsum Prod-

ucts," which is now being printed and should be available in the near future at the office of the Superintendent of Documents, Government Printing Office, Washington, D. C. Announcement of the price will be made in the Bulletin the usual way.

THE ABRASIVE HARDNESS OF CERAMIC GLAZES

The modern potter does not thoroughly understand why some ceramic glazes resist abrasion and cutlery marking better than others; consequently the Bureau of Standards¹ is investigating (a) the factors which influence glaze hardness and (b) means of manufacturing a hard low-fired glaze. The abrasive hardness (or resistance) of glazes is determined by (1) abrading their surfaces with Ottawa silica sand, and (2) measuring the effect of the abrasion.

The abrading apparatus now in use is smaller in design but depends on the same principles as the one described in the Journal of the American Ceramic Society, volume 7, No. 5, May, 1924. Recent development has led to many changes in details, one of which provides means for weighing the sand used in each test. The effect of the sand is determined by means of the Ingervall glarimeter.² This instrument serves to estimate the gloss of a glazed surface before and after abrasion, the difference being proportional to the amount of the abrasive treatment.

A systematic study of 49 experimental glazes (which were prepared at the bureau) has been started. Observations concerning the following factors have been made: (a) Variations in silica and alumina, (b) variations in glaze thickness, and (c) temperature at which the glazes were fired (within their maturing ranges). Only 15 of the 49 glazes have been examined. The data obtained indicate that (a) hardness varies in direct proportion to SiO_2 , no other factor being variable; (b) as Al_2O_3 increases uniformly from 6 to 10 per cent the hardness remains uniform, from 10 to

¹ Technical News Bulletin No. 97.

² Central Scientific Co., Bull. No. 100, May 1, 1924.

12 per cent Al_2O_3 it is reduced materially, and again increases from 12 to 16 per cent Al_2O_3 (the 18 per cent Al_2O_3 glaze failed to mature); (c) thickness apparently affects hardness appreciably, there being a definite maximum thickness-hardness relation (when represented graphically) in the cases examined; and (d) variations in firing within 1 or 2 cones did not appear to affect hardness. However, the hardness of the high alkali glazes increased considerably upon firing them to cone 9 instead of cone 5.

The experiments conducted thus far are necessarily preliminary rather than conclusive, but it is believed that fundamental progress is being made on the investigation.

STANDARDIZATION OF SEGER CONES

Segger cones are used quite generally in the ceramic industries for gaging the firing of clay ware and other ceramic products. For want of a better term they are frequently called "pyrometric cones." They are placed in kilns with ware to be fired and indicate during the firing the combined effects of average rate of firing, furnace atmosphere, and final temperature attained. The exact relationship between the indications of cones and the factors just mentioned has remained undetermined for years, while ceramic practice has developed and the need for accurate control of firing has increased.

The usefulness of cones depends upon knowledge of their refractoriness and reaction with furnace gases. The standardization supplies this knowledge. There was some doubt before the work began that cones when fired would behave in a sufficiently definite manner to allow their standardization. It was soon learned that when a cone is heated in a definite manner its behavior can be quantitatively described; that is, the standardization was found to be practicable.

The work supplies not only the information required but furnishes, also, through attention to the methods employed, useful knowledge of the nicety

of control required in firing any ceramic material to obtain a uniform product. The limitations and imperfections of cones are revealed. For example, some cones react peculiarly with furnace gases, others are particularly sensitive to changes in rate of heating, while most of the more refractory cones are not very sensitive to either of these factors.

The use of pyrometers and the accuracy of temperature measurements required in the work demonstrate that in the manufacture of high-grade clay products, where nicety of kiln control is essential, pyrometers are almost indispensable. It is known that the most progressive ceramists now combine the use of recording pyrometers and Seger cones.

The work is now nearly completed, and the results are being assembled and analyzed for publication. It is planned to have preprints of this report, prepared by the American Ceramic Society, distributed so that the work can be criticized before publication in the journal. The report will also be presented at the next annual convention of the Ceramic Society in February, 1926, for discussion, and final publication will be delayed until March, 1926. In order to avoid confusion in ceramic literature, no preliminary nor summarized report will be published. It will be observed from the above that the nature of the results is such that summarizing in brief form is impracticable, and they can not, therefore, be made available before the final publication.

BLUE GLASS FOR FURNACE WORK

A blue glass which will absorb the ultra-violet rays has been developed by the bureau for protecting the eyes of foundrymen and other furnace workers. Safety engineers have insisted that men working around open-hearth or other high-temperature furnaces use a brown glass which reduces the intensity of the light from the furnace and also offers good protection against the ultra-violet rays. However, the furnace operators themselves prefer a blue glass regard-

less of the fact that it only gives partial protection against the ultra-violet rays, maintaining that they can observe furnace conditions better through a blue than through a brown glass. This prejudice is probably due to their greater experience with a blue glass, because brown glasses are now being extensively used with satisfactory results in some industries.

The blue glass recently made at the bureau has, in addition to the color and other desirable properties of the ordinary blue glass, the very desirable property of furnishing protection against the ultra-violet rays. The glass can be made by replacing about half the lime in a soft soda-lime glass with cerium oxide and adding sufficient cobalt oxide to produce the desired color.

RECOVERY OF RARE SUGARS FROM WASTE RESIDUE LIQUORS OF DEXTROS INDUSTRY

Since the bureau was able to show that dextrose could be produced readily on a commercial basis, the industry has grown by leaps and bounds. Already the value of the products is perhaps in the millions of dollars. Now, the bureau has shown that the waste residue liquors (commercially known as hydrol) contain gentiobiose, a rare sugar of exceptional interest in organic chemistry. In addition, it has been shown that Fischer's isomaltose, a compound also of exceptional interest in organic chemistry, contains gentiobiose.

If glucose sirup, the nondextrose part of which is evidently an intermediate product in the process of forming dextrose from starch, contained gentiobiose and isomaltose, and at the same time isomaltose contained no gentiobiose, then it would be logical to conclude that both isomaltose and gentiobiose are intermediate products; but if glucose sirup were found not to contain isomaltose or gentiobiose, and at the same time gentiobiose could be found to be a constituent of isomaltose, then the only conclusion to make would be that gentiobiose and isomaltose are reversion products.

The bureau's experiments showed that glucose sirup contains no isomaltose or gentiobiose, and that Fischer's isomaltose contains gentiobiose. This is of considerable practical value because it shows the following:

1. That gentiobiose and isomaltose or starch conversion liquors are reversion products caused by the application of the present method of hydrolyzing starch with hydrochloric acid.

2. The reversion process depending on such factors as quality and ratio of materials, time and temperature of conversion, etc., no conversion liquors of uniform composition and working qualities can be achieved without previously finding means for strictly controlling the above factors.

THE PREPARATION AND TESTING OF PAINT FILMS

Work was continued during the past month on methods of preparing and testing paint films. A method has been developed that gives better oil-paint films (in the bureau's experiments) than the method of coating paper with glue size. The bureau found that films 5 by 8 inches in size can readily be prepared by coating a sheet of rag paper with two or three coats of gum-arabic solution, allowing to dry, applying the paint over this size coat, and when dry soaking the paper in water until the paint film lifts off. This film, while still in the water, is placed over a tin frame. On drying the film is thus kept from curling or shriveling.

AGING TESTS OF RUBBER

Most persons have had more or less experience with the deterioration of rubber compounds. For instance, a hot-water bottle may become hard and cracked within a very short time, a short circuit may occur in the vacuum-cleaner cord because the rubber insulation has become brittle and has broken, the garden hose may leak because of failure of the rubber tube, or a pair of rubber gloves which have been stored for a long period may be found worthless because the rubber has lost its life. It has prob-

ably also been observed that one rubber compound will last far better than another. While considerable experimental work has been carried on dealing with the aging of rubber, and it is known that certain ingredients in rubber compounds or certain treatments of the compounds yield poor or good aging stocks, the fundamental causes of aging are not known.

Within the last year the bureau has started an extensive investigation of the aging of rubber with three objects in view: First, to determine the cause of the deterioration of rubber; second, to find means to prevent it; and, third, to devise laboratory tests by which the life of a rubber article can be predicted with more accuracy than is at present possible. The work to date has been confined to four different rubber compounds ranging from "pure gum" to a highly compounded stock containing reclaimed rubber. Each stock was vulcanized for three different periods, making a total of 12 different rubbers under investigation. The various factors which might affect rubber, including heat, light, oxygen, moisture, etc., have been as far as possible isolated, and the influence on each of the rubbers is being determined. The results to date show some very marked differences in the aging properties of the four compounds and in the way in which they are affected by the different treatments to which they are being subjected. In general, it is noted that the "pure gum" compound has, as a whole, the poorest aging properties, while one of the stocks which is the most affected by heat is the least affected by light, and in contrast one which is rapidly affected by light will withstand heat the best. It is planned to publish a preliminary report covering this work in the near future.

UNEVEN SILK CAUSES STREAKY HOSIERY

The National Association of Hosiery and Underwear Manufacturers for some time has supported a research associate as because the Bureau of Standards. Among the problems recently submitted by manufacturers who are members of this

group was one dealing with a defect in hosiery. A study of this matter brought out the importance of using silk of uniform diameter.

The hosiery in question had two contrasting colors in a "pepper-and-salt" design, formed by using viscose rayon and Japan silk. The specimen was very streaky. An examination showed that the rayon was uniform in diameter, 150 denier, 18 filament viscose, but the silk was very uneven in diameter. The count of the filaments of the silk showed a range from 24 to 40 filaments, a variation in actual size of about $1\frac{1}{4}$ threads. The greatest variation occurred at the streaky places. To correct this condition in the future it is recommended that in purchasing the manufacturer specify the number of filaments per individual thread.

STANDARDS FOR PAPER TOWELS

The bureau recently completed an investigation having for its object the development of specifications for purchase of paper towels by Government departments. The cooperation of manufacturers and consumers was secured, and a wide range of products covering all grades available was tested.

The basic raw materials used in paper toweling range from fibers produced by repulping waste papers and containing a large constituent of ground-wood fiber, up to fibers produced entirely by chemical processes and using special modifications designed to impart the peculiar properties desired.

The properties of prime importance are absorbency, strength, and cleanliness. As the natural softness and absorbency of wood fibers are considerably lessened by the usual treatment given to develop strength, the maximum quality in both these respects is difficult to obtain. The higher-grade products have these two desirable qualities combined, but considering the price differential, unless economy in use can be assured, towels possessing a medium degree of both absorbency and strength are considered satisfactory.

Test methods for determining quality were studied. A method was evolved

for determining absorbercy, consisting of placing 0.1 c. c. of water on the surface and noting the time required for complete absorption. The bursting test is considered suitable for measuring strength.

There is lack of uniform practice as regards size, basis for expression of weight, unit of purchase, and unit of packaging, and adoption of standards in these respects would be beneficial to all concerned. The bureau makes the following recommendations: Size, 11 by 13 inches; basis of weight, 25 by 40,500; unit of payment and of packaging, 1,000.

The minimum quality of towels acceptable for general use should fall within the following limits: Weight, not more than 42 pounds (25 by 40,500); absorption time, not more than 180 seconds; bursting strength, not less than 8 points.

PUBLICATIONS OF THE BUREAU OF STANDARDS ISSUED DURING OCTOBER

Scientific Papers

S509. Alternating current distribution in cylindrical conductors; Chester Snow. Price, 15 cents.

S511. A nonintermittent sensitometer (time-scale exposure machine) with clock-controlled motor drive; Raymond Davis. Price, 15 cents.

S512. Temperature estimates of the planet Mars; W. W. Coblentz. Price, 10 cents.

Technologic Papers

T290. Relation between heating value of gas and its usefulness to the consumer; E. R. Weaver. Price, 30 cents.

T291. Tests of hollow tile and concrete slabs reinforced in one direction; Douglas E. Parsons and Ambrose H. Stang. Price, 25 cents.

T293. Condensation of water from engine exhaust for airship ballasting; Robert F. Kohr. Price, 25 cents.

T294. Wearing qualities of tire treads as influenced by reclaimed rubber; W. L. Holt and P. L. Wormeley. Price, 5 cents.

T295. Initial temperature and mass effects in quenching; H. J. French and O. Z. Klopsch. Price, 10 cents.

T296. Flow in a low-carbon steel at various temperatures; H. J. French and W. A. Tucker. Price, 10 cents.

Circulars

Supplementary list of publications of the Bureau of Standards. Price, 10 cents.

Miscellaneous Publications

M64. History of the standard weights and measures of the United States; Louis A. Fischer. Price, 15 cents.

M68. Adjust your headlights. Price, cents.

OUTSIDE PUBLICATIONS

Geodetic instruments from the viewpoint of the physicist, L. V. Judson, Bulletin of the National Research Council, Vol. 10, Part 3, p. 36; July, 1925.

Application of radio-transmission phenomena to the problems of atmospheric electricity, J. H. Dellinger, abstract in Bulletin of the National Research Council, Vol. 10, Part 3, Number 51, p. 61; July, 1925.

Concerning the nature of fading, J. H. Dellinger Radio News, Vol. 7, p. 270; September, 1925.

Solving the mysteries of radio, J. H. Dellinger and C. B. Jolliffe, Federal Employee, Vol. 10, No. 9, p. 12; September, 1925.

A method for testing gas appliances to determine their safety from carbon monoxide, E. R. Weaver, J. H. Eisenman, and G. B. Shawn, Gas Age Record, Vol. 56, pp. 241, 281, 319, 1925.

Esparto as a paper-making material, M. B. Shaw, G. W. Bicking, R. L. Rumsey, Paper Trade Journal, Vol. 81, No. 12, p. 55; September 17, 1925.

Recent paper research of the Bureau of Standards, B. W. Scribner, Paper Trade Journal, Vol. 81, No. 13, p. 5; September 24, 1925.

Bureau of Standards investigations of pottery, heavy clay products, glass and enamels, ceramic division studies the Ceramist, Vol. 6, No. 5, p. 60; August, 1925.

The effect of storage of calcined gypsum upon the linear expansion of gypsum plaster, L. E. Smith, Rock Products, October 2, 1925.

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